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ARE OUR ENGINEERING SCHOOLS TURNING OUT WELL-ROUNDED GRADUATES?

By G. E. Hilbert, Chief of the Bureau of Agricultural and
Industrial Chemistry, U. S. Department of Agriculture

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by P. H. Groggins, Technical Advisor to the Chief of Bureau

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I am very glad to have the opportunity to talk with this group about engineering education, in which we all have a primary interest. You are concerned, as I am, with the question I have been asked to discuss this evening: Are our engineering schools turning out well-rounded graduates? Or, in other words, Do our engineering courses provide an adequately balanced education? This is of course not a new question, and as you know it is hardly an easy one to answer.

One way of getting at the facts of the matter might be to trace carefully the careers of a large number of recent engineering graduates, and then to try to determine how successful each of them has been and what the reasons are for their success or failure. Surveys of this kind have been made, on a relatively small scale; but I think we can agree that the information they are intended to provide is very difficult to obtain with accuracy. Many different factors may limit individual achievement — a simple lack of native ability, for instance; or lack of initiative and "drive"; or perhaps just plain bad luck. But we cannot overlook the possibility that a gap or flaw in an engineer's education may also be an important cause of his failure or only partial success in his profession. However, even if his education is lacking in some essential, that fact may be hard to determine.

In this connection, it has long seemed to me unfortunate that we cannot maintain closer contact between the teaching staffs of engineering schools and the alumni. I feel that the fault is largely with the alumni. When they visit their alma maters — and if they do — it is usually for class reunions or similar gatherings. As you well know, on these occasions they seem to be interested mainly in re-living, or even re-enacting, their student days. Too few alumni take advantage of such opportunities to reestablish contact with their former teachers, to discuss common problems with them, and

to exchange information that might be helpful in evaluating or guiding the school's educational program.

As a poor substitute for a thorough alumni survey, I would like to give you some of my thoughts on engineering education, particularly since they seem to be shared by many of the alumni I know. Most of us seem to agree that our engineering schools are doing a splendid job of teaching scientific and engineering principles. And if engineers were able to devote all their time just to applying these fundamental principles in their daily work, I think it might be said that engineering schools are turning out well-nigh perfect graduates. But the fact is, of course, that to do their jobs well engineers must have a knowledge of many things besides engineering principles.

Many of us, for a short time after graduation, possibly believed that the fundamental information and training we received in engineering was the main thing we needed to ensure our success. But gradually — and perhaps ruefully — we learned that much more than engineering was actually necessary. Perhaps our most important discovery was this: that a knowledge of how to communicate information and ideas, and how to deal with other people, is about as important and generally useful to us as our stock of technical information.

Organizations that employ engineers seek particularly men who are versatile and adaptable, who can grow into positions of leadership and administrative responsibility. This type of competence cannot be measured solely in terms of technical ability or background. A great many of the problems faced by engineers in their daily work — and at times the most important ones — cannot be solved simply by engineering. Besides sound professional ability, the well-rounded engineer needs other capacities which I feel should be given greater attention in engineering schools. Two of them I have already mentioned:

First, an engineer should be able to communicate facts and ideas effectively.

Second, he should be able to get along well with other people.

A third type of training that also seems to me important is training in the principles of good administration. I want at least to mention the need for this third type of training, although I do not plan to discuss it in detail. Good administration, which many engineers need to know more about, is closely related, I feel, to good communications and good human relations. Practically all engineers need to have an appreciation of administrative problems and procedures to assist them in the primary task of getting things done as members of complex modern organizations.

Skill in communication — in writing and speaking — and in dealing with people seem to me practical necessities for engineers today. Perhaps in emphasizing the need for more training along these lines, I may appear to have taken too narrow a view of the kind of education required to produce "well-rounded" engineers. Study of the humanities, for instance, certainly has a place in the well-rounded engineering curriculum. But I feel that elemental training in communications skills and in human relations is basic to the broader type of education, as well as necessary to engineers from the purely professional standpoint.

II

From the time an engineer begins his college studies until he reaches the upper rungs of whatever professional ladder he has chosen to climb, he must have the ability to express his thoughts and to convey information clearly and concisely in writing. And the higher he gets in his profession, the more he will need also the ability to make a satisfactory speech, or otherwise to express himself orally. The fact that good writing is an art

does not excuse poor writing by engineers. And the notion that good speakers are born and not made is an unfortunate one for engineers to have, particularly since for the most part it is untrue.

Knowing how to write is of great importance, for instance, in research work, where the presentation of good reports is an essential part of the job. The end product of most research is information — accurate information, which can be translated into production and profit. And unless this information is satisfactorily presented, the technical investigations which produced it will have been in vain. In the laboratories of the Bureau of Agricultural and Industrial Chemistry we employ quite a number of chemical engineers, who are responsible for the application of sound chemical engineering in our investigations of methods for converting farm products to industrial and other uses. In this type of work, which is based on research, the preparation of good engineering reports is about equal in importance to the research itself.

Whenever administrators of technical organizations get together, the discussion will sooner or later turn to the subject of technical writing. I believe it is safe to say that they are virtually unanimous in the opinion that too many technical men are poor writers. I personally feel that the need for better writing ability on the part of technical people is a point that can hardly be overemphasized.

I am afraid, however, that the effort made to give engineers better training in writing and speaking at the college level has been unduly subordinated in many cases. For the most part this essential phase of their education has been left to the English and speech departments of the liberal-arts faculties, and only a small percentage of each student's time in college is devoted to learning communications skills. Perhaps it would be unjust to say that the engineering faculty has no interest in the student's ability to handle the English language, but I feel that in all too many cases students

definitely get the impression that the courses in English they are forced to take have only a remote relation to their professional training and are relatively unimportant for their future work.

Something should be done to correct this impression wherever it exists. At this point I might emphasize that many schools have already taken steps to ensure that students are made aware of the importance of good report writing. A considerable number of those in this group have themselves devised methods of integrating or combining training in communications skills with engineering studies. At several colleges, I understand, students are graded rather severely on the reports they submit for their engineering courses. Although this practice is not initially popular with the students, it seems to bring about a considerable improvement in their writing and speaking in a rather short time. Of course, we in Government and industry also have responsibilities in this educational field. We too may need to keep a more critical eye on the reports of our employees and to assist them in becoming better writers.

Emphasizing good writing and speaking throughout the engineering course seems to me particularly necessary in view of the fact that so little time can be devoted to a separate study of language skills. Most technical courses, at some point or other, require the application of these skills. Giving writing and speaking close attention in these courses — and not merely in English courses — seems to me the only solution of this educational problem. In any such effort, close liaison with the English departments would of course need to be maintained.

III

The second ability I mentioned as necessary for engineers to have is the ability to get along well with other people. An engineer invariably

needs a knowledge of the principles of good human relations. This knowledge has a direct bearing on the broader aspects of his education, such as those with which courses in the humanities are concerned; and it is also indispensable in the engineer's everyday life, where he must, for instance, rub shoulders with many kinds of people — scientists, skilled mechanics, laborers, perhaps even management executives.

It seems to me worth noting that discussions, conferences, and exchanges of ideas are almost daily occurrences for an engineer. Such meetings are a practical necessity today in the achievement of scientific and engineering progress. And if they are to proceed smoothly and produce useful results, it is necessary for those who participate in them to understand each other's mental processes and to be tolerant of viewpoints other than their own.

The value to the technical man of the complex art of getting along with others is particularly apparent in modern research. The way in which research and technical studies are now conducted places a premium on men who can get along well with others. Hardly more than a decade or two ago, most scientific problems were ordinarily studied and solved by individuals — that is, by lone workers. But in recent years there has been a greatly increased emphasis on the use of teams, composed of various kinds of technical experts, to solve difficult and important research problems. The development of the atomic bomb, penicillin, radar, and the proximity fuse are striking examples of what can be done by such teamwork. In the future it is likely that more and more of our scientific and engineering problems will be attacked in this way. Not only have we found that teamwork provides solutions to problems more quickly than the older method, but also the increasing specialization that is taking place in the physical sciences today makes research teamwork a virtual necessity.

In a recent editorial for Chemical and Engineering News, Walter J. Murphy commented on this trend. He made reference to a statement by Nobel-prize-winner

Arne Tiselius, who cautioned not long ago against the tendency toward overspecialization in the physical sciences. In writing about this problem, Murphy pointed out that the "tremendous expansion in many specialized fields . . . has reached the point where it is now evident . . . that to obtain the maximum benefit from this new torrent of knowledge, we must develop scientists who have the rather uncanny ability of being able at least to interpret specialized data" in a number of related fields. "Otherwise," he said, "much of the potential value associated with our new specialized techniques is lost."

But Murphy also recognized that "only a very small percentage of scientists can be expected to retain such a broad approach, for the demands made on individuals in the specialized fields of science become greater and greater as the frontiers are explored in more minute detail. "The practical answer," he says, "appears to be more teamwork in scientific research."

An outstanding industrial research director -- Robert E. Wilson of the Standard Oil Company (Indiana) -- recently spoke of the necessity for teamwork in science in these terms: "We must," he said, "have more and better organized expeditions into the unknown if we are to bring back results." Going further with the analogy between scientific investigations and geographic exploration, he said that the "time has long passed when a Daniel Boone, with rifle and pack horse, could add greatly to our store of knowledge. To make significant additions today requires a well-organized Byrd expedition, going to extremely remote places with a plenitude of scientific equipment and observers."

Our civilization owes a considerable debt to the cloistered scientist and the lone inventor, who made their contributions in a highly individualistic manner. But in the future it is likely that scientific and technological progress will depend increasingly on complex organizations of workers. And this means, of course, an increase in the demands put upon technical people

to get along with each other satisfactorily and to communicate with each other effectively.

IV

In discussing the importance of good communications and good human relations from the standpoint of the engineer, I have tried merely to give a few examples of why training in these fields seems to me necessary. But of course teaching engineering students to be better writers, and educating them in how to improve their relations with other people, is hardly a simple undertaking. None of us has any illusions about that. Moreover, this educational problem, like a number of others, is not made any easier by the current tendency toward overcrowding in most of our colleges. But since a great deal of thought is being given these days to devising an educational program that will provide engineers with a better-rounded education, I feel that additional training along these lines should receive more emphasis.

Perhaps the first step necessary is a more thoroughgoing agreement among engineering educators and their students concerning the importance to engineers of skill in handling the language and in dealing with people. Only if this agreement is reached can we expect that a way will be found to give more adequate education of this kind.

I have thought it might be a good idea for senior engineers, and perhaps other engineering students as well, to have greater opportunity of hearing talks by successful practitioners of their profession in industry, government, private research foundations, and elsewhere, so that they might learn more about the actual conditions they will face in their jobs after college. No doubt something along this line is already being done in many schools. Colleges might well call upon their successful alumni to give such talks in the interest of the profession. I am sure that these alumni speakers — a substantial number of whom might be scheduled throughout the school year —

would emphasize the value of versatility and adaptability in engineers; the importance of good writing and speaking; and the necessity of understanding human relations, both for getting a job and later for carrying out successfully the administrative responsibilities that engineers are so often called upon to assume. More and more today, engineers are being offered employment opportunities in administrative jobs and in sales work where technical knowledge is required. Talks by engineering alumni in these fields would, I am sure, bring out the need for men with superior communications ability and skill in human relations to fill the newer kinds of jobs open these days to engineers.

To sum up: the working conditions faced by scientists and engineers in today's world make it necessary, more than ever before, that engineering graduates know how to get along well with others, and how to write and speak understandably. These skills are intimately related to an understanding of how to keep that sense of balance and proportion which makes great accomplishment in any field possible. It would seem that engineering schools might well make a new and more vigorous effort to provide more adequate training along these lines. And while the abilities I have mentioned are of immense practical value to engineers in their professional life, they are also, I believe, fundamental to the development of well-rounded individuals in all affairs of life — the kind of people that the world needs in increasing numbers today.

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